Unit 3 Review Answers

Student Textbook pages 248–252

Answers to Understanding Concepts Questions

1. A homogeneous mixture contains two or more substances mixed together in such a way that the two substances cannot be distinguished, e.g., sugar in water. A heterogeneous mixture meanwhile contains two substances that can be distinguished, e.g., carbonated water, in which the bubbles of carbon dioxide are visible.
2. Solute is broken down into smaller particles (endothermic). Intermolecular bonds of solute and of solvent are broken (endothermic). Intermolecular bonds formed between solute and solvent (exothermic). The amount of energy released in this last step generally determines whether the process will be endothermic or exothermic.
3. Moles per litre (mol/L): used when describing concentration of acids and industrial products. Percent by weight (w/w) or percent by mass (m/m): for commercial products such as hydrogen peroxide. Percent by volume (V/V): for consumer products such as alcohol. There is also percent by mass/volume (m/V). Pollutants are often cited in terms of parts per million (ppm) or even parts per billion (ppb).
4. Since a saturated solution contains the highest ratio of solute to solvent possible for a given mixture, it will always be "concentrated."
5. Solubility is defined as the amount of a substance (solute) that can be dissolved in another (solvent). It will vary according to the chemical nature of the solutes and solvents, as well as with the temperature and pressure.
6. 4 g Fe(aq)

7. 1×10^{-5} g $P_4(aq)$; 4×10^{-7} mol/L P_4

8. The table sugar has considerably fewer moles present. So the salt solution is more concentrated.

9. (a) $[NH_4^+] = 4.12$ mol/L, $[Cl^-] = 4.12$ mol/L

(b) $[Ba^{2+}] = 0.275$ mol/L, $[OH^-] = 0.550$ mol/L

(c) $[NH_4^+] = 1.629$ mol/L, $[PO4^-] = 0.543$ mol/L

10. (a) $c_2 = 0.250$ mol/L HCl(aq)

(b) $c_2 = 0.21$ mol/L $NaNO_3(aq)$

(c) $c_2 = 0.577$ mol/L $(NH4)_3PO_3(aq)$

11. Scale build-up is typically caused by $CaCO_3(s)$ deposits. The chemical reaction is:

$2CH_3COOH(aq) + CaCO_3(s) \rightarrow Ca(CH_3COO)_2(aq) + H_2O(l) + CO_2(g)$

Students could expect to see the carbon dioxide bubbles, and possibly an increase in temperature could be observed.

12. The acid in the lemon juice is more concentrated by a factor of 1000.

13. Providing that you knew electrolytes to be ions in aqueous solution, you could infer that acids and bases are electrolytes, since the Arrhenius theory refers to the creation of hydrogen and hydroxide ions in solution.

14. Water has a pH of 7 since it has equal amounts of hydronium and hydroxide ions present.

15. (a) Strong acids and bases dissociate into ions 100%, whereas weak acids and bases do not. Strong base = NaOH(aq), strong acid = HCl(aq), weak base = $NH_3(aq)$, weak acid = HF(aq).

(b) The terms concentrated and dilute refer to the amount of moles of acid or base initially present in solution, not the concentration of the ions after dissociation has occurred.

16. (a) The 0.10 mol/L solution would generate more hydronium ions per litre than the 0.010 mol/L solution. The 0.010 mol/L solution would therefore have a higher (weaker) pH.

(b) The base generates hydroxide ions that reduce the concentration of hydronium ions, giving it a higher pH.

(c) The solution with a pOH of 7 has a greater concentration of hydroxide ions than the solution with a pOH of 8. Since hydroxide ions reduce the concentration of hydronium ions, the solution with a pOH of 7 would have a higher pH. Or, use the fact that pOH = 14 – pH.

(d) The weak acid ionizes less than the strong acid, producing fewer hydronium ions per litre, giving it a higher pH.

(e) The strong base dissociates 100% into hydroxide ions, giving it a lower pOH and therefore a higher pH.

(f) $H_2SO_4(aq)$ is a strong acid and so would have a lower pH than $HSO_4^-(aq)$.

17. (a) pH = –0.36

(b) pH = 3.845

(c) pH = 1.7

Answers to Applying Concepts Questions

18. Begin with a conductivity test to divide solutions into three categories: strong electrolytes, weak electrolytes, and non-electrolytes. This would identify the $C_{12}H_{22}O_{11}(aq)$ since it is the only non-electrolyte. The dilute (0.010 mol/L) NaOH(aq) solution ought to be less conductive than the more concentrated one, but more conductive than the weak base. Next, a litmus paper test can divide the strong conductors into acids, bases, and neutral ionic solutions (HCl(aq), 0.1 mol/L NaOH(aq), and NaCl(aq), respectively). A similar (but more sensitive) test on the weak electrolytes would also divide them into the weak acid, $CH_3COOH(aq)$, and the weak base, $Na_3PO_4(aq)$.

19. (a) bromocresol green: blue, orange IV: yellow, phenolphthalein: colourless

(b) pH $\approx$ 10

20. The pH of the stream could vary for the following reasons: temperature affects solubility of acid rain carrying solutes, industrial activity varies throughout the year, wind patterns shift the dispersal of pollutants.

21. Procedures should be similar to that of question 18, but could also include vigorous reaction with magnesium or zinc strips.

22. When a saturated solution is at equilibrium a certain number of particles are in the solid state, while a certain number have been dissolved. Over time, individual particles change from being solid to dissolved and back again, but the aggregate numbers of particles in each state do not change. The drawing should highlight the cyclical nature of this process.

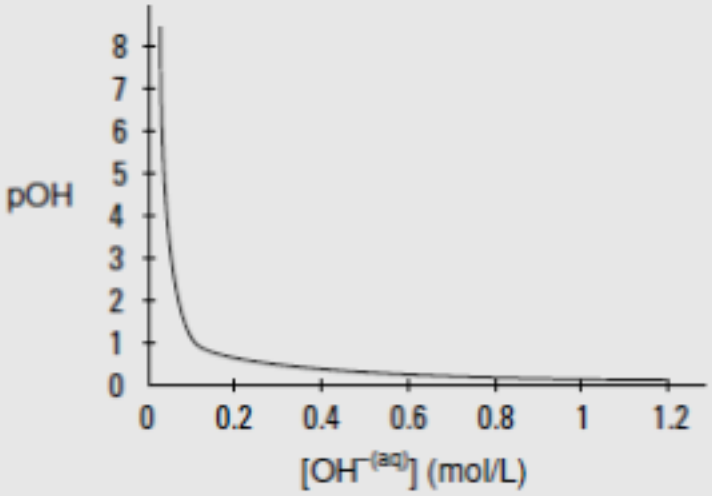
23. Student posters should depict appropriate glasswork, WHMIS symbols, and laboratory equipment, and should be easily read from distance of ZM.

24. See answer to question 3.

25. (a) The acetic acid is a weak acid and dissociates so little that it produces only as many hydronium ions per litre as the considerably less concentrated strong acid of HCl(aq).

(b) Students will be tempted to suggest that since the acids have the same pH, they are equally "strong." Encourage students to use a different term, such as "potency," leaving "strong" to describe acids that dissociate 100%.

26.



27. Answers will vary, but students could point out benefits such as the various industrial, commercial, and medical roles acids and bases play, while contrasting this with the role of these chemicals in pollution, acid rain, and the weapons industry.

28. (a) [KCl(aq)] = 37 g/100 mL

(b) [NH_4Cl(aq)] = 70 g/100 mL

(c) [NH_4Cl(aq)] is highest for temperatures of 20°C or higher.

(d) [NH_4Cl(aq)] is the most affected by temperature.

29. Dissolve 91.6 g of ammonium chloride in 200 mL of water. The solution should appear clear. To ensure that all of the ammonium chloride dissolves, the water should be heated to slightly above the desired temperature. Once the solution starts to cool off, a precipitate of ammonium chloride should start to form.

Answers to Solving Problems Questions

30. $[(NH_4)_3PO_4\ (aq)] = 5.03 \times 10^{-2}$ mol/L

$[NH_4^+] = 1.51$ mol/L, $[PO_4^-] = 0.0503$ mol/L

31. 0.250 L

32. 2.4×10^{-3} L

33. 1.2×10^2 g $CuSO_4.5H_2O(s)$

34. $V_1 = 0.107$ L; $V_{water} = 0.643$ L

35. (a) pH = 0.388

(b) pH = 1.16

(c) pH = 5.393

36. The hydronium ion concentration has been reduced to half its original concentration so the solution is slightly less acidic. The pH was increased by only 0.3 of a pH unit from 1.60 to 1.90.

37. From lowest to highest: HCl(aq), 0.10 mol/L HF(aq), 0.010 mol/L HF(aq), NaCl(aq), NH_3(aq), NaOH(aq), $Ba(OH)_2$(aq).

38. (a) pOH = 2.73

(b) pOH = 1.220

(c) pOH = 12.301

39. 6.4×10^{-4} g HBr(g)

40. 6.4×10^{-4} g $Sr(OH)_2(s)$

Answers to Making Connections Questions

41. Since vitamin A is a fat-soluble vitamin, it needs to be digested in conjunction with fats in order to be absorbed by the body. Diets that are low in fat are at risk of causing vitamin A deficiency.

42. Key sources of lead poisoning in children are in older houses where it was often used in paints, radiators, duct covers, and even some pottery. Lead poisoning can increase blood pressure and cause fertility problems, nerve disorders, muscle and joint pain, irritability, and memory or concentration problems. Long-term effects may include lower IQ scores and even death.

43. (a) The presence of $HCO_3^-(aq)$ ions acts as a buffer to maintain a relatively stable pH around 7. The sulfate ion is a weak base and so causes the pH to increase slightly in the Banff Upper Hot Springs, while the presence of sulfurous acid decreases the pH in Miette.

(b) Solubility of solids tends to increase with temperature, so the warmer months of summer ought to increase the number of dissolved solids.

(c) Despite a pH of below 7, swimmers need not be concerned since the pH of rainwater is around 5.5.

44. The main concerns are potential spills, although excess pollution from truck transports, including noise pollution, could also be issues. Generally cities try to route dangerous goods away from heavily populated areas and create noise barriers to help reduce noise pollution.

45. Homemade sports drinks are relatively easy to make, being a mixture of sugar, water, and salts containing sodium and potassium. Using fresh orange juice or lemon juice will provide enough sodium and potassium. Generally these drinks provide approximately 14 g of sugar, 100 mg of sodium, and 40 mg of potassium per bottle. Aside from the cost of ingredients, students should consider the time and effort required to make the drinks, as well as packaging in an appropriate travel-proof container.

46. In the first example, the HCl(aq) should have the higher electrical conductivity since it is a strong acid and produces more ions. In the second example, water is the primary ion contributor, so both solutions have the same conductivity.

47. In order to cause hydrangeas to bloom purple, aluminum sulfate is generally added to reduce the pH of the soil to around 5.2–5.5. In order for them to bloom pink, the pH needs to be raised to around 6.0–6.2 by adding phosphorus-containing fertilizers. A pH of above 6.4 can cause damage to the flowers, as they lose iron.

48. Most of these pollutants occur either through industrial refining processes, or through burning of impure hydrocarbons. Better methods of recapture and filtration, along with taller smokestacks to promote a wider, less concentrated dispersal, can help reduce industrial pollution. Alternative fuels and catalysts can also play a large role in reducing pollutants from hydrocarbon combustion.

49. **(a)** Drain and oven cleaners are often the leading source of concentrated strong acids and bases used in the home.

(b) In most cases, there are simpler, safer alternatives such as the one discussed in the Chapter 6 Connections (student textbook p. 242). Enzymatic cleaners can also used to clean ovens and drains.

(c) Enzymatic cleaners typically cost more than traditional cleaners. Advertising and lack of awareness can also be factors that discourage the use of alternatives.

50. Scurvy is caused by a vitamin C (ascorbic acid) deficiency. Citrus fruits such as oranges, lemons, and limes are high in vitamin C.

51. The people in the helicopters may be liming the lake to reduce the effects of acidification. Calcium carbonate reacts with acids in a neutralization reaction. Adding limestone to a lake can reduce the damaged caused by acid precipitation by neutralizing the lake.